DESKTOP AUDIO SYSTEM

Andrew Lynch

Kamal Sanghi

Chris Grahn

THE PROBLEM

- At any given time, there are multiple audio sources on my desk
  - MP3 player (iPod)
  - Desktop Computer
  - Laptop Computer
  - Police Scanner
- Most speaker systems allow one or possibly two inputs
- Lots of analog cables

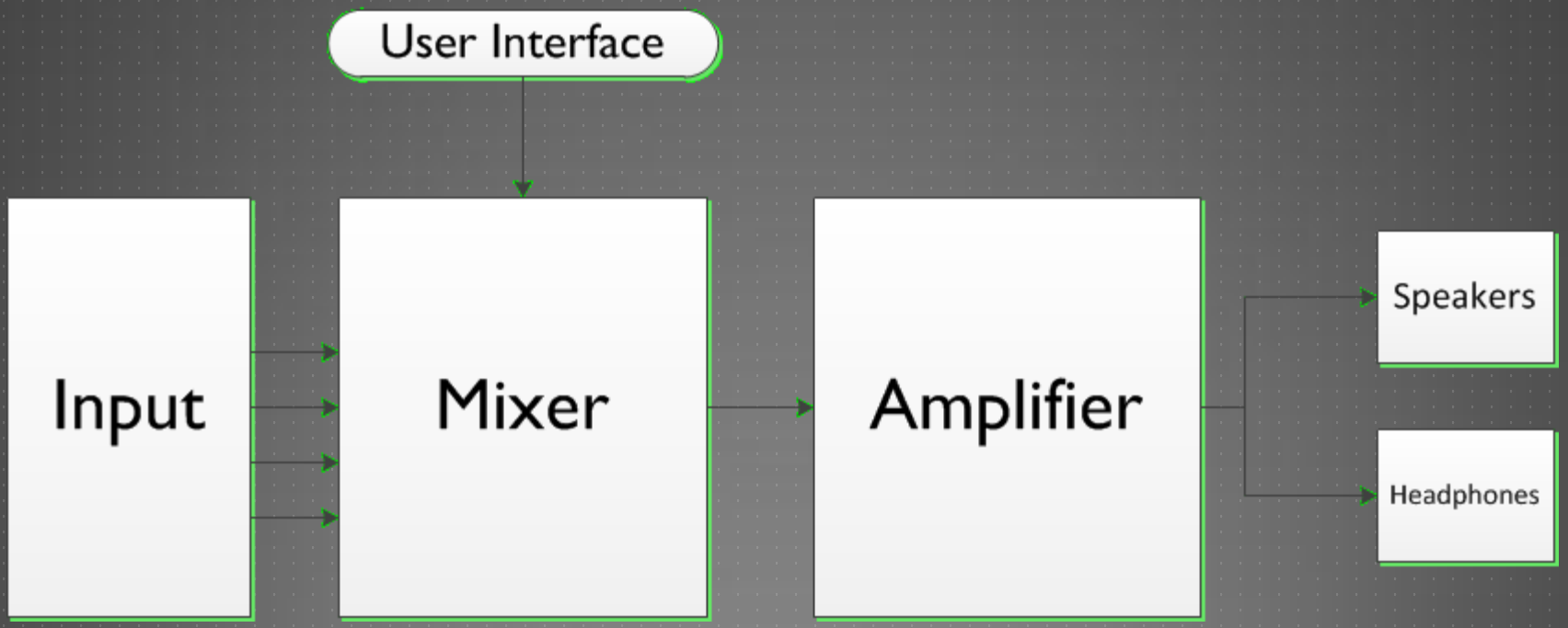
THE PROBLEM

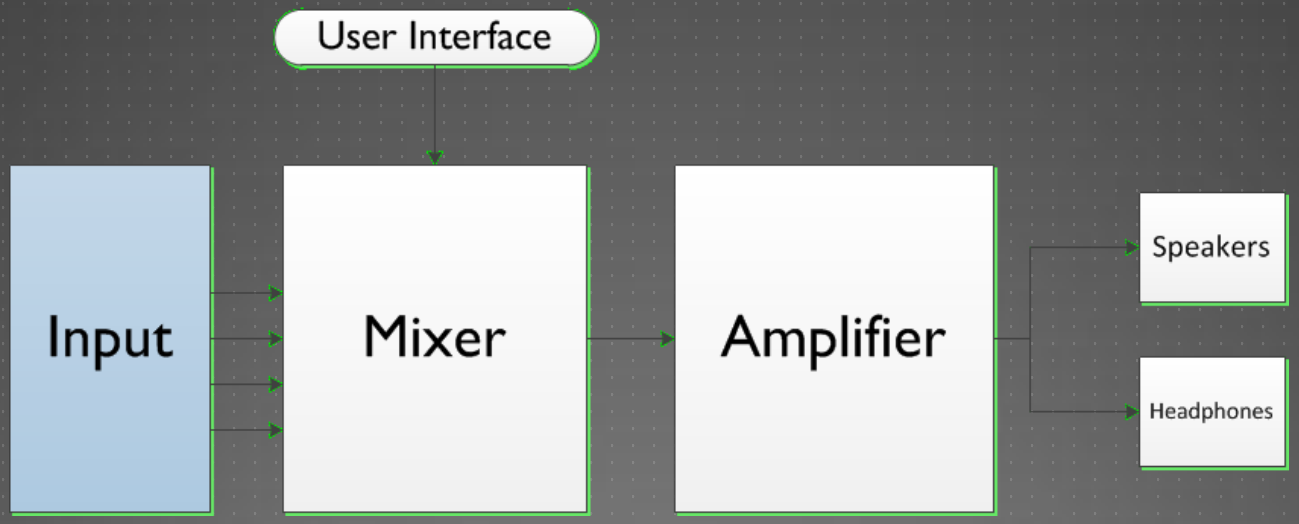
- Current Solution:
  - Behringer DJ mixer
    - Advantages: Allows mixing of up to four inputs, has line out to be passed to powered speakers
    - Disadvantage: Large footprint on desktop, headphone level is product of main output level, all analog.
  - Powered Logitech speakers
    - Simple 2.1 sound system
    - Audio quality is OK, but I'd like to use some nice bookshelf speakers instead
  - All Analog
    - Would rather use USB audio out of the computer, frees up the audio card on the desktop for other duties
- Proposed project: Combine these discrete components

REQUIREMENTS

- Mix up to four analog stereo inputs into one stereo output
- Provide two USB->Audio converters built in
  - Hook up a computer via USB for audio, instead of analog
  - These will take the place of two analog inputs
- Include an amplifier for both headphones and unpowered speakers
- Standalone or computer-controlled operation

BASIC FLOW CHART




User Interface
Input
Mixer
Amplifier
Speakers
Headphones

INPUT STAGE

INPUT STAGE

- Digital to Analog Converter
- Amplify any signal to 2.5v

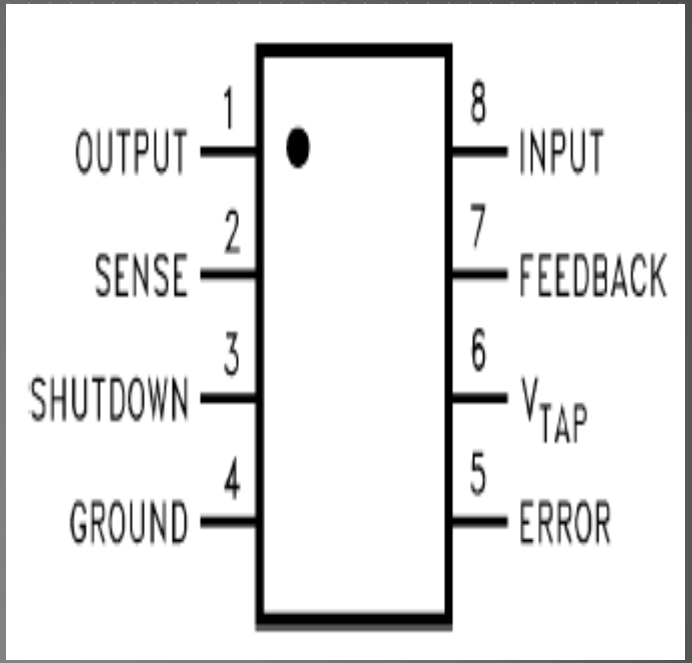
DIGITAL TO ANALOG CONVERTER

- Main Components
  - IC PCM2902
  - IC LP2951CM
  - 12 MHz Crystal

LP2951CM

- Features
  - Low dropout voltage
  - Low quiescent current
  - High accuracy output voltage
  - Easily Available

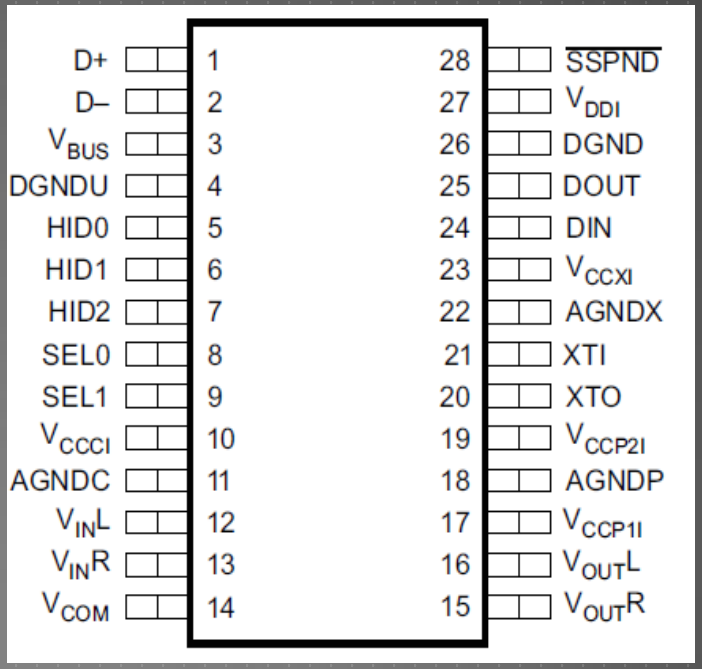
PIN Configuration



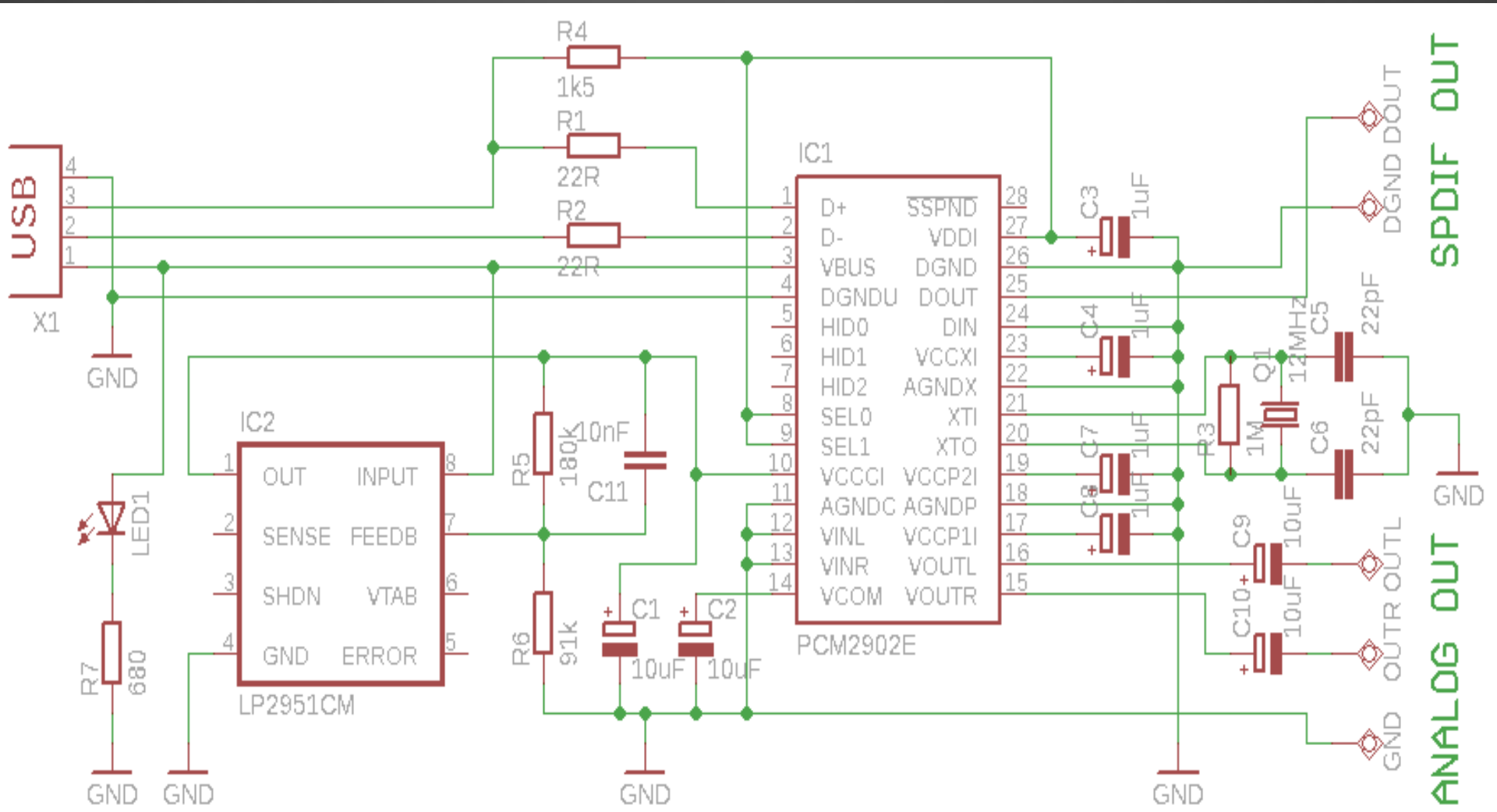
PCM2902

- Features
  - Multifunction
  - Needs no software
  - USB adaptive mode for playback
  - Bus powered
  - Not depend on operating speed

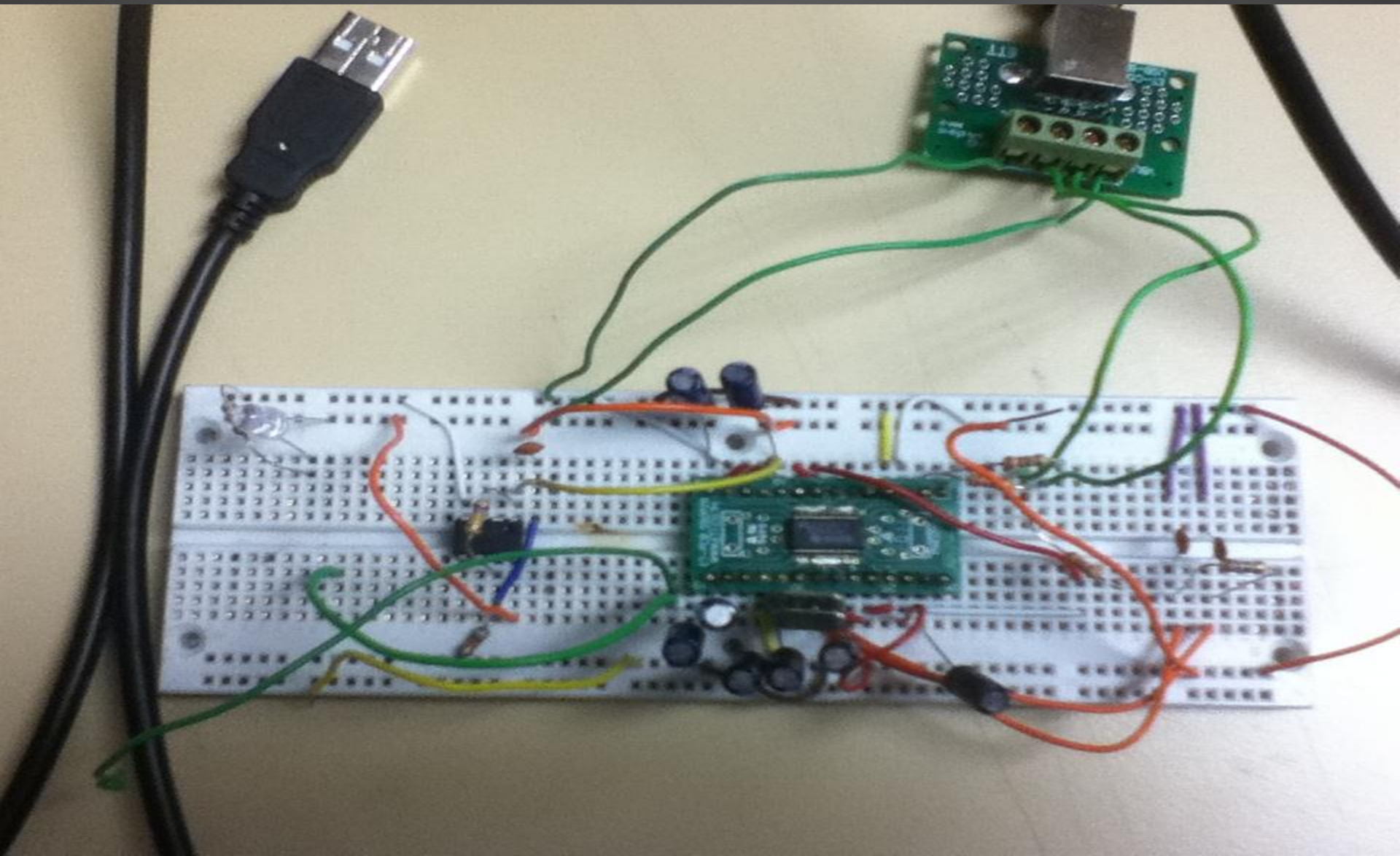
PIN Configuration



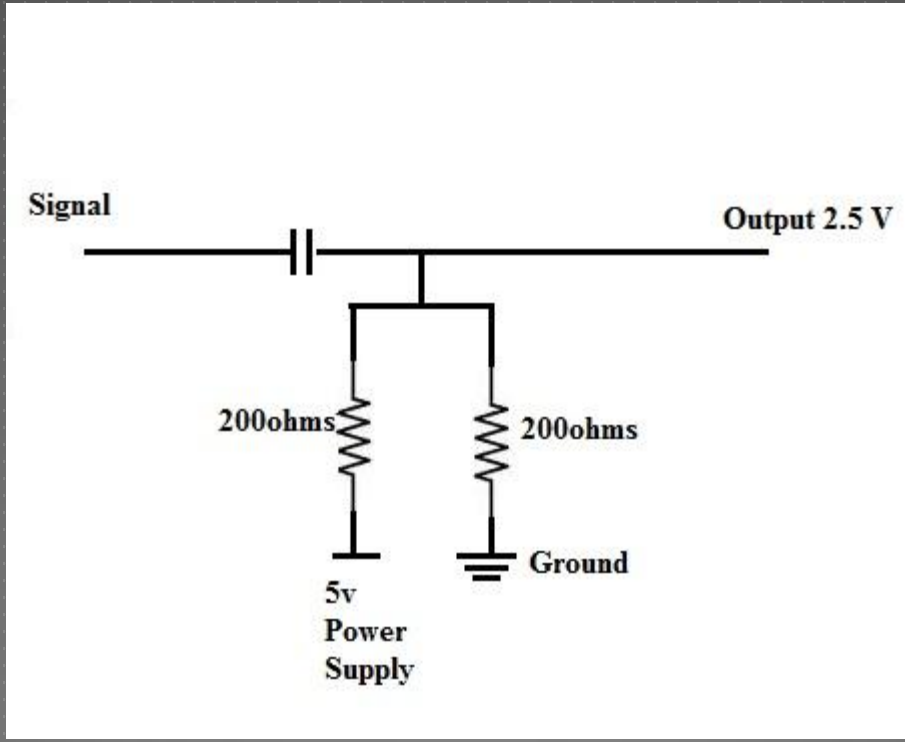
DIGITAL TO ANALOG CONVERTER

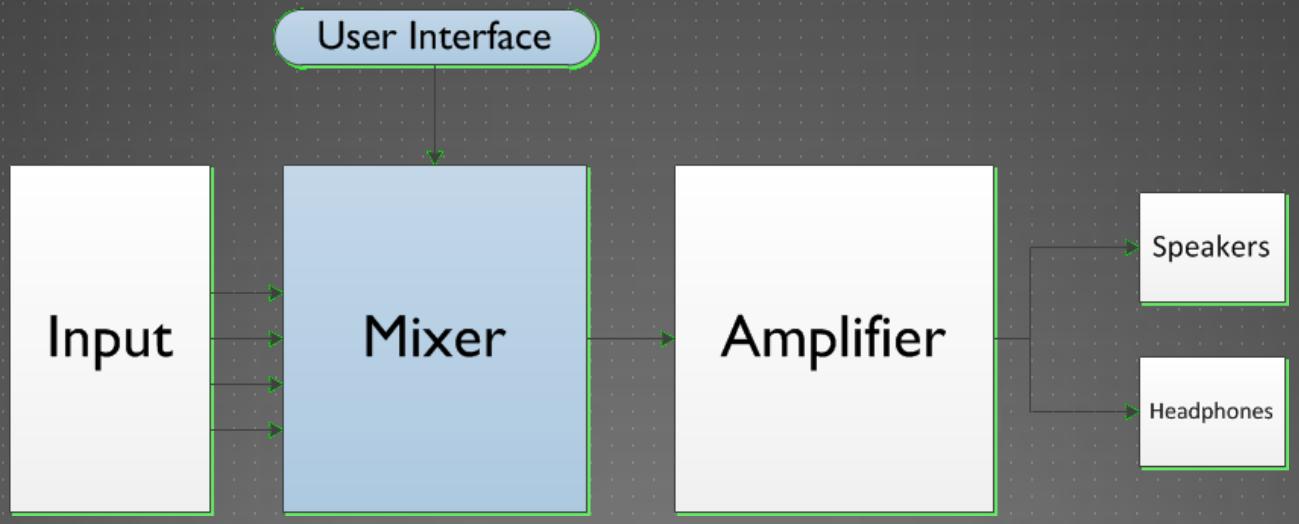


DAC BREAD BOARDED CIRCUIT



2.5V OUTPUT CIRCUIT




User Interface
Input
Mixer
Amplifier
Speakers
Headphones

MIXER STAGE

MAIN COMPONENTS

- Digital potentiometers
  - Dallas Semi. DS1807
  - Use I2C to communicate
- Arduino Duemilanove
  - Based on an Atmel 328 chip (similar to PIC)
  - Existing "Wire" library for I2C communication
  - Simplified USB-based prototyping board

ARDUINO

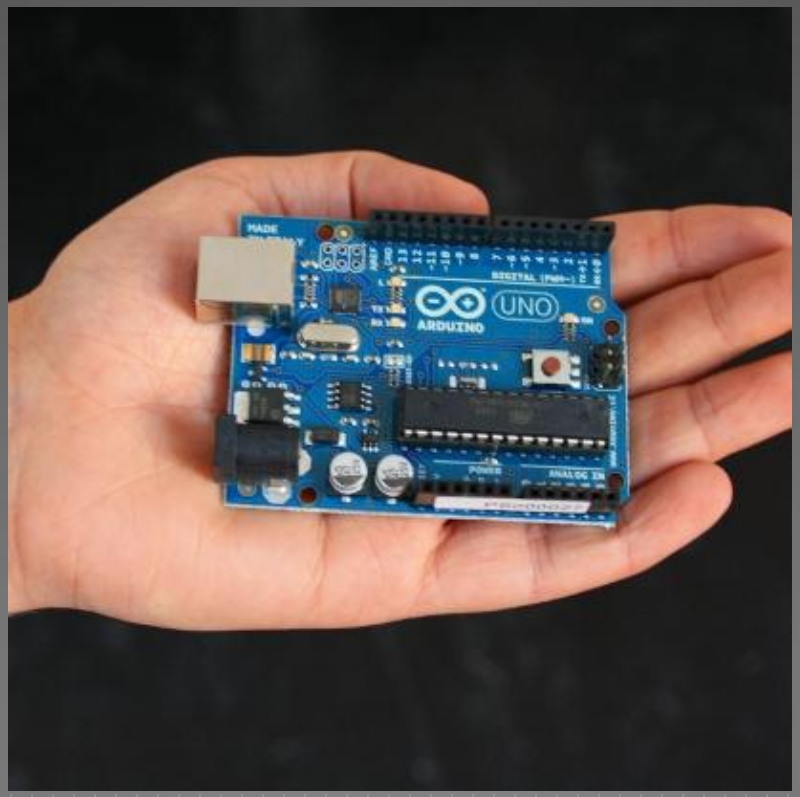
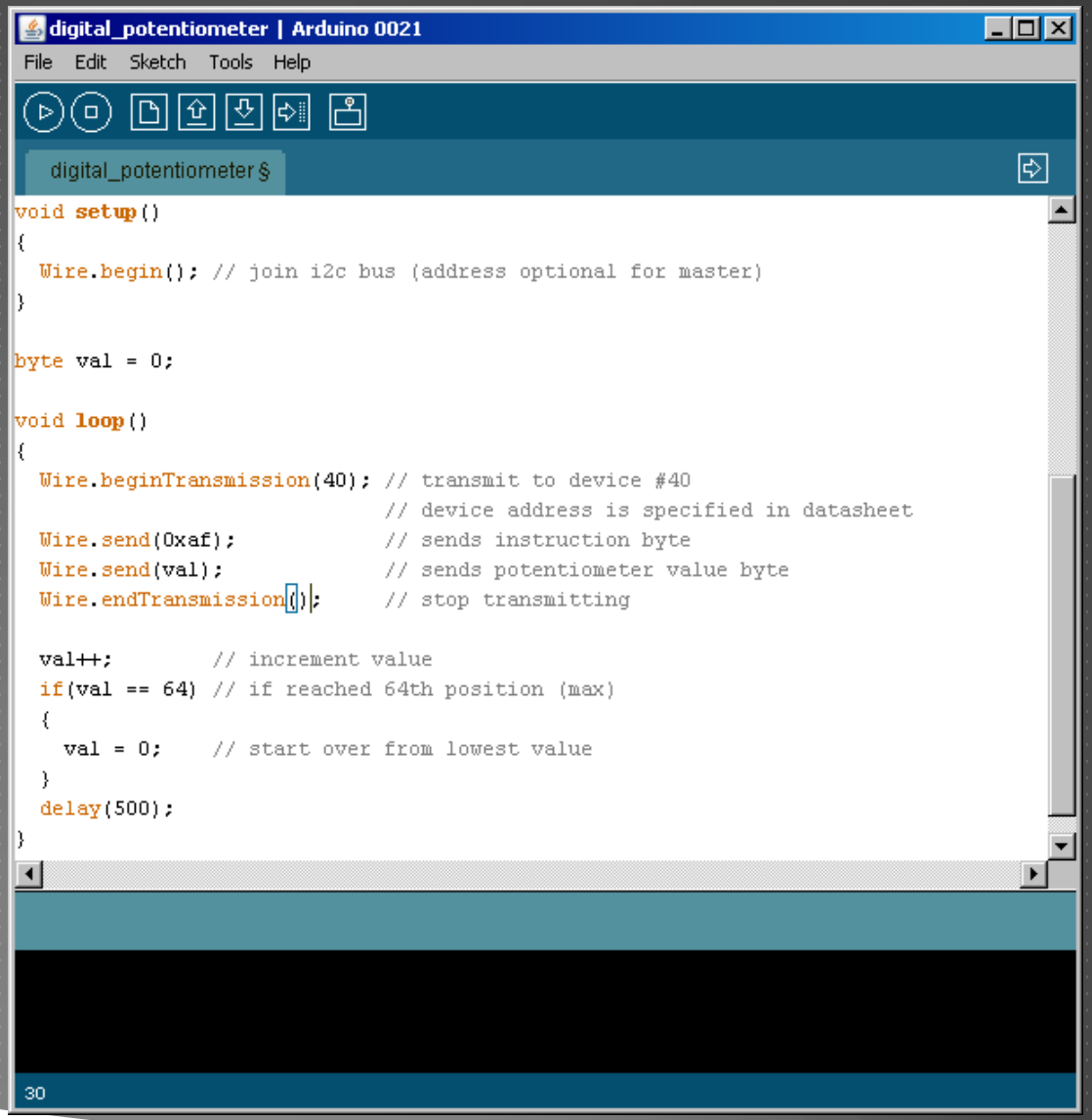


Image provided by www.arduino.cc

ARDUINO

- Freely available IDE and compiler
- Very easy to use programming language (C++-like)
- Example program shown with Wire library for I^2C communication

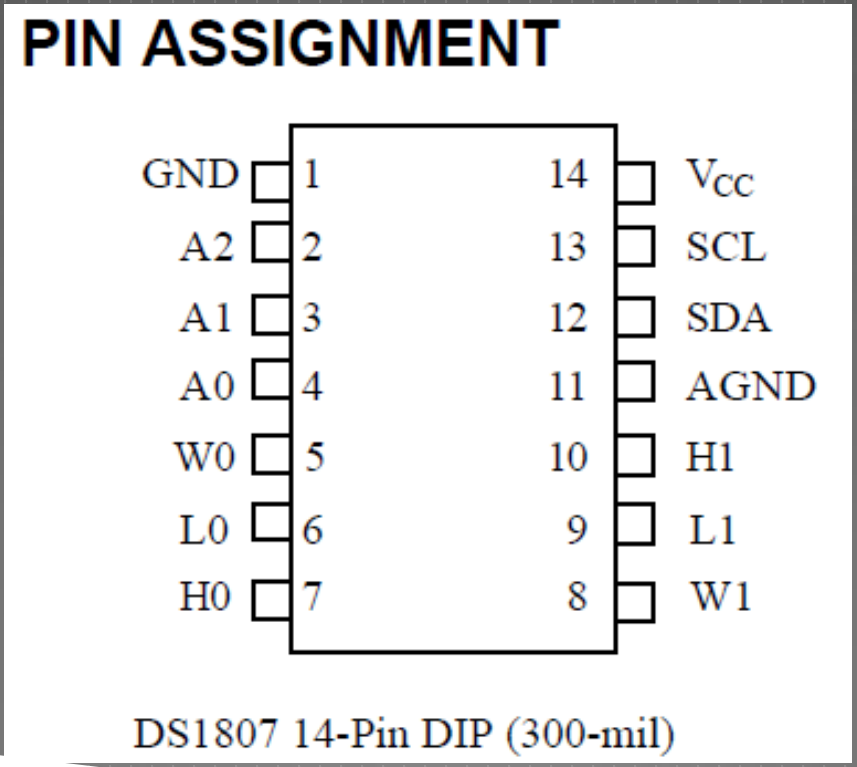


I²C DIGITAL POTENTIOMETERS

- Advantages of I²C Bus
  - Bus architecture allows for one set of communication lines
  - Components only respond if they are told to (compared to SPI)
  - Each device is individually addressable
- Disadvantages
  - Protocol overhead – you can't write to all the chips at once, you have to go one at a time
  - Requires more processing to write an instruction (speed/latency)

I²C DIGITAL POTENTIOMETERS

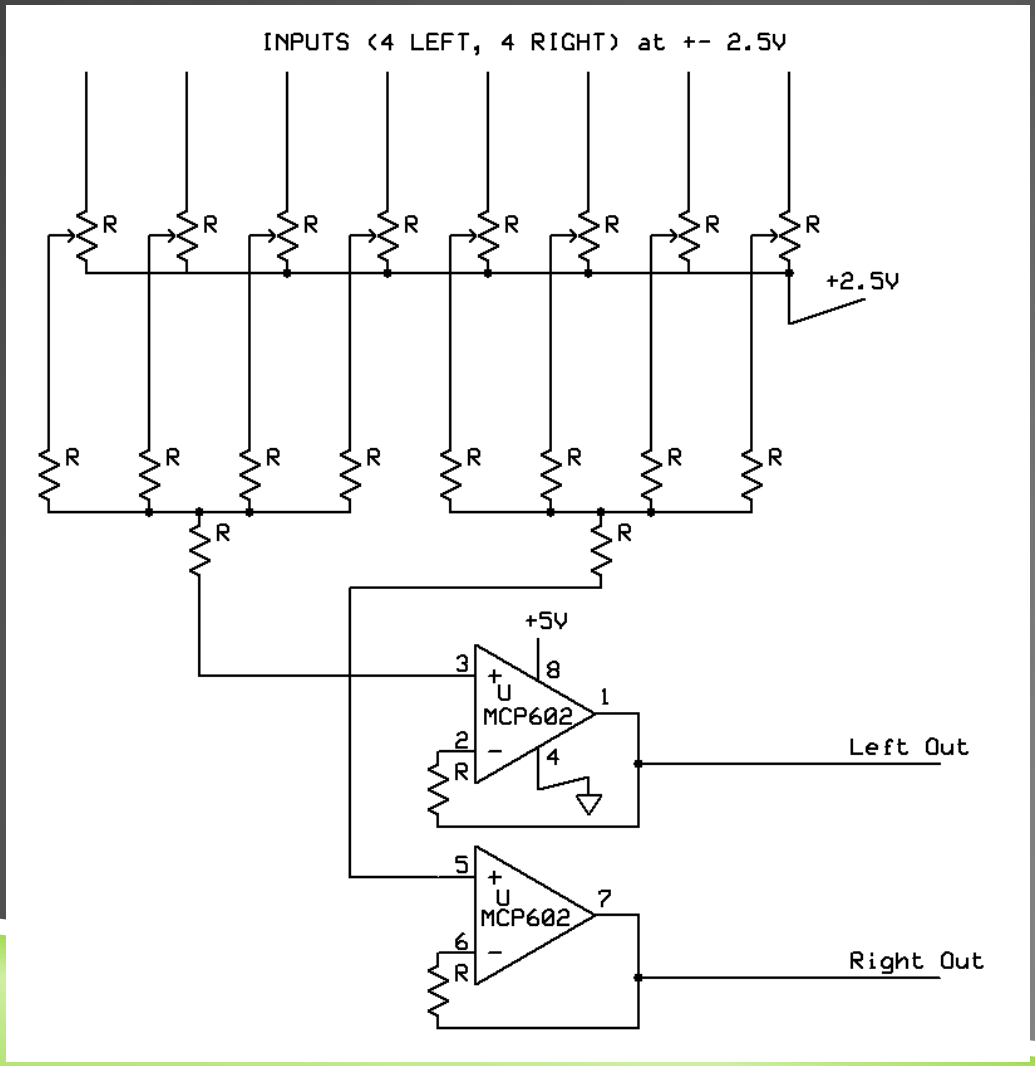
- Chip: Dallas Semiconductor DS1807



I²C DIGITAL POTENTIOMETERS

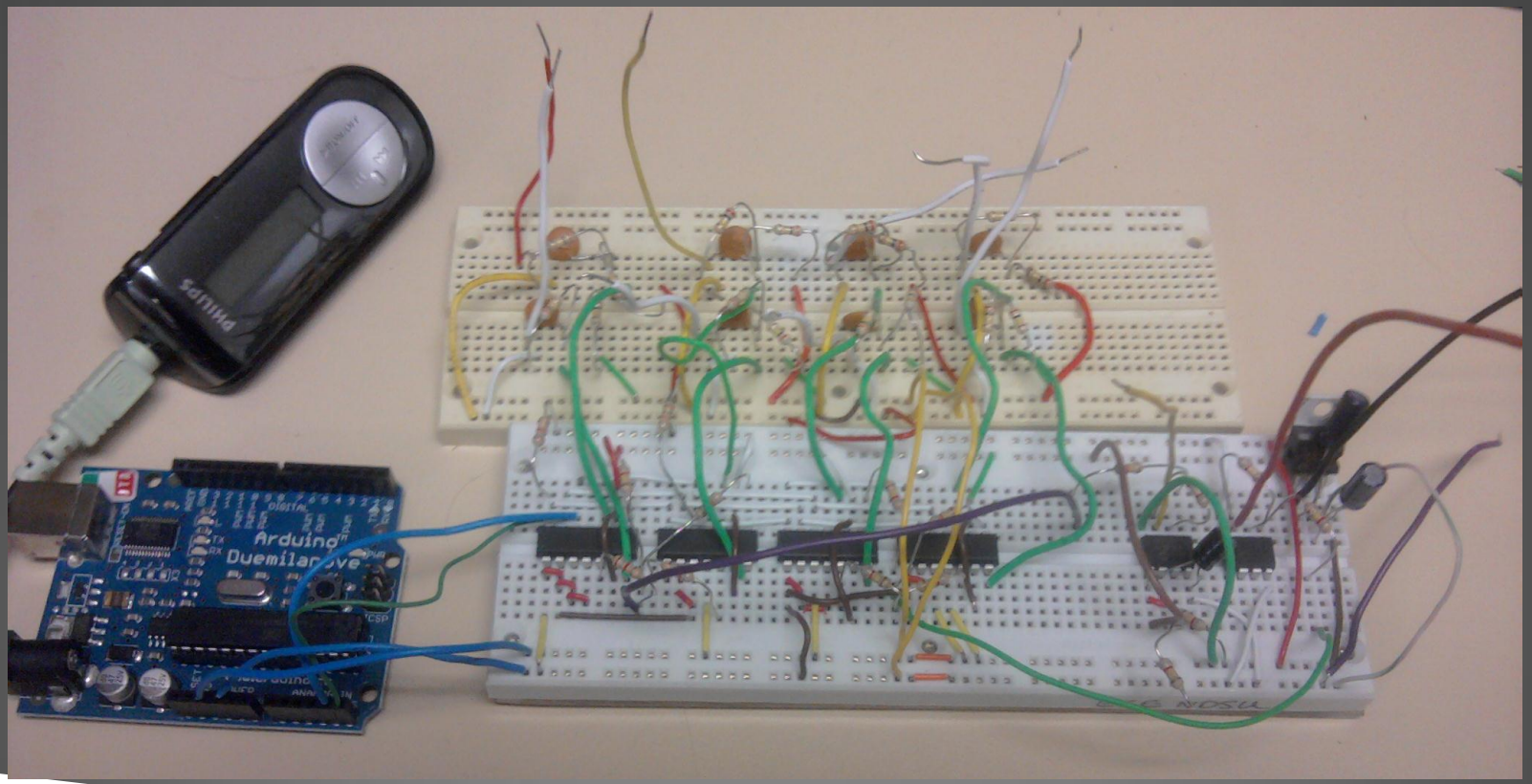
- Chip: Dallas Semiconductor DS1807
  - Designed for audio applications
  - Log taper – 1dB increments, 65 total
  - Readily available from Digi-key

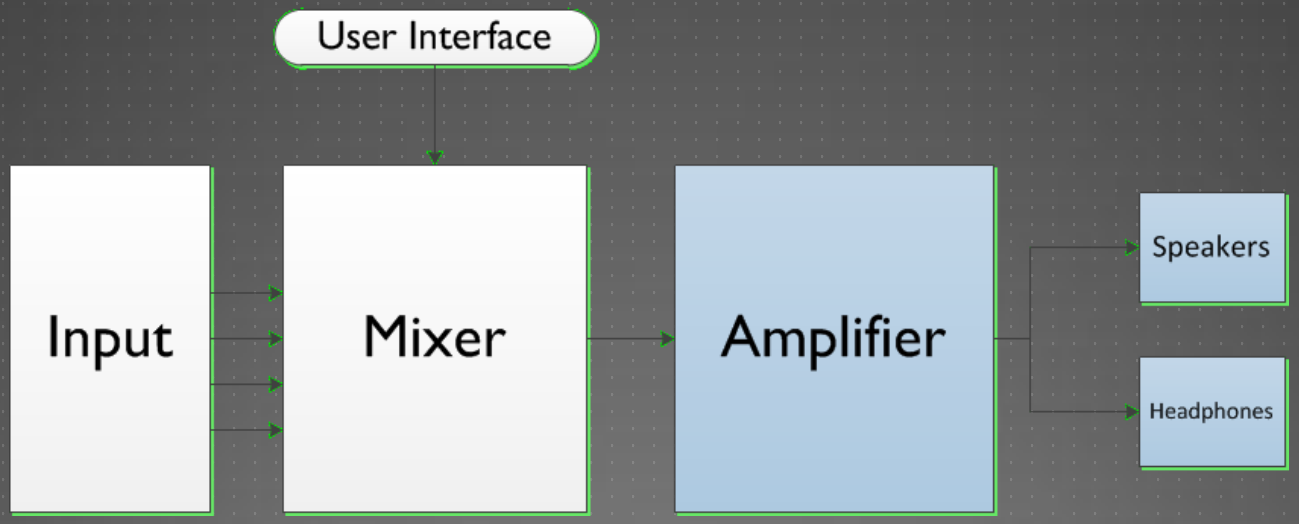
SCHEMATIC



- Inputs are designed to be from the Input Stage
- 2.5V supply provides ground
- MCP602 Op-Amp is set up as a summing amplifier.
- All passive resistors are of 820K value. 1M was used in reference design, but 820K was readily available.

PICTURE – INPUT AND MIXER



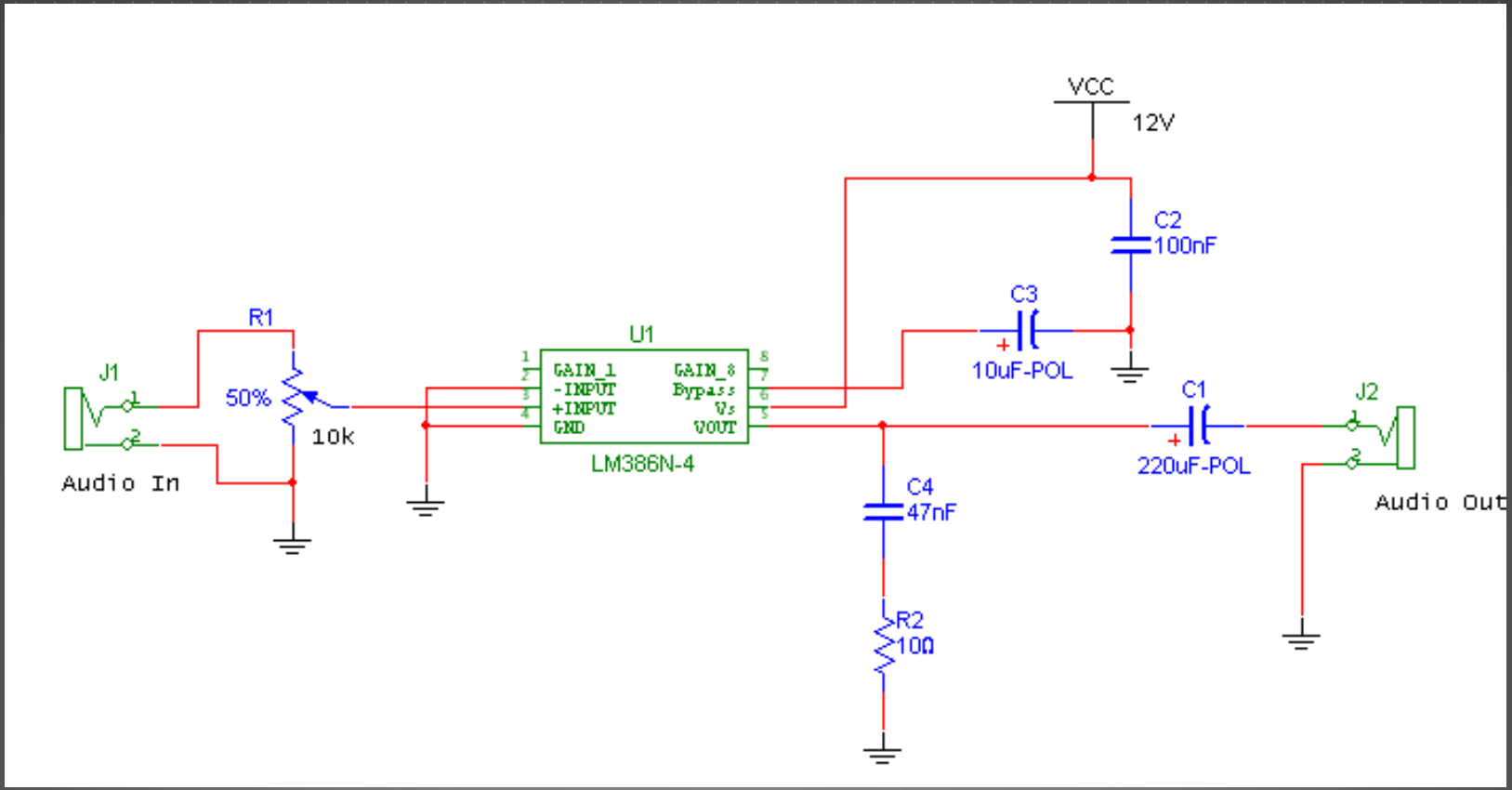


AMPLIFIER STAGE

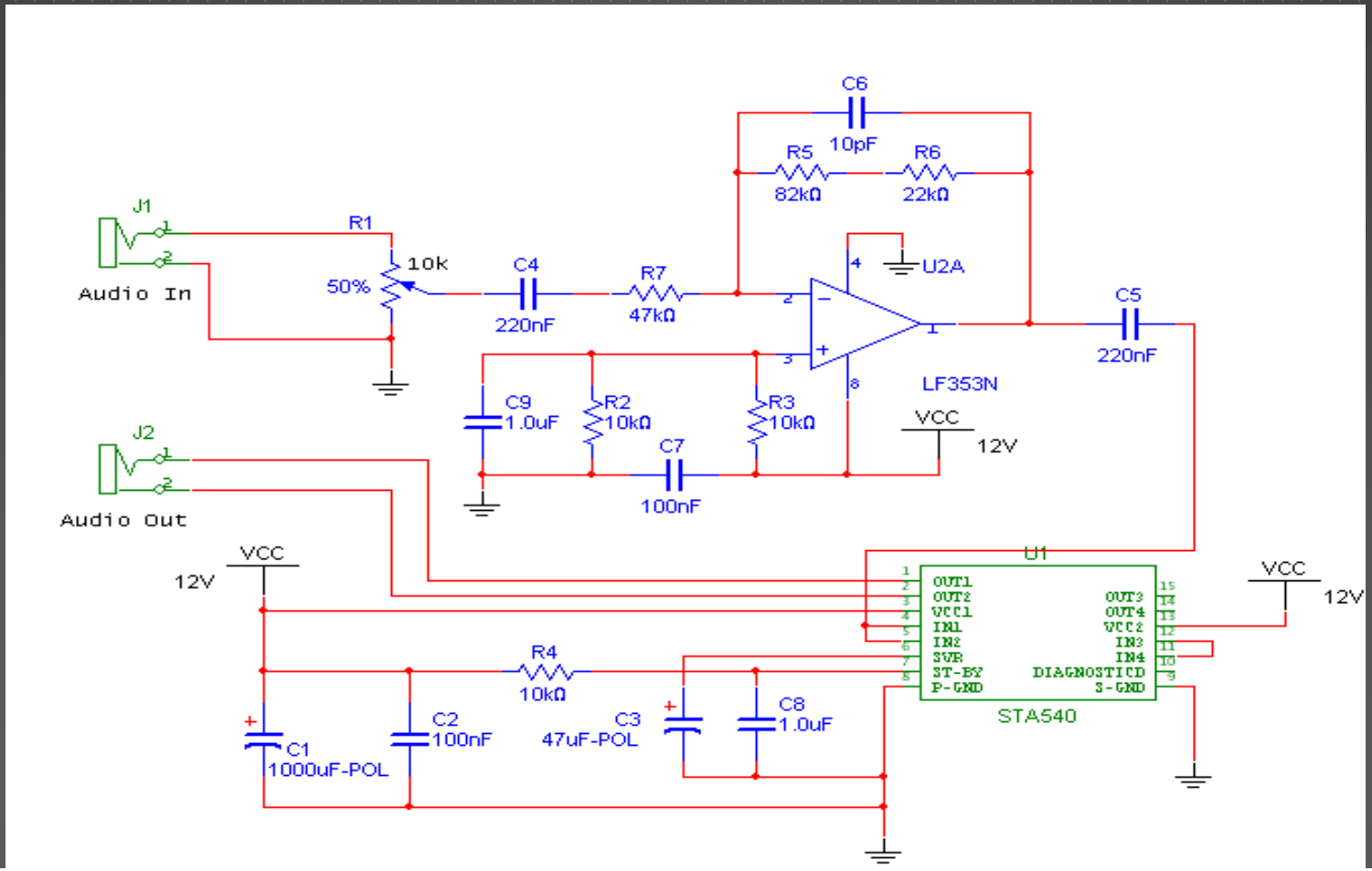
AMPLIFIER STAGE

- Headphone Amplifier
  - Uses LM386 for amplifier
  - Design based off of minimum parts design in application section of datasheet
- Speaker Amplifier
  - Uses STA540 for amplifier
  - Design based off of dual bridge application circuit in datasheet
  - Uses LF353N op-amp for input buffer
  - Design based off of STA540 audio amplifier kit from Sparkfun Electronics

HEADPHONE AMPLIFIER SCHEMATIC



SPEAKER AMPLIFIER SCHEMATIC



PROJECT STATUS

- Input Stage
  - ~~Amplify any signal to 2.5v~~
  - ~~Analog to digital converter~~
  - Duplicated Analog to Digital converter
- Mixer Stage
  - ~~Selection of digital potentiometers~~
  - ~~Interface digital potentiometers with Arduino~~
  - ~~Build mixing circuit~~
  - User Interface
    - LCD
    - Rotary Encoders
- Amplifier Stage
  - ~~Headphone amplifier for single channel~~
  - ~~Speaker amplifier for single channel~~
  - Add headphone amplifier for second channel
  - Modify speaker amplifier to support two channels
  - Add +12V voltage regulators and extensive filtering to reduce noise from power supply
  - Design lowpass filters for audio input to reduce noise from digital electronics in previous stages

BUDGET

Name	Quantity	Unit	Total	Retail
10K digital pot	5	2.4	12	12
10K Audio Pot I2C	5	7.32	36.6	36.6
Rotary Encoder	5	3.6	18	18
PCM2900E SSOP	2	12.34	24.68	24.68
LP2951	2	0.6	1.2	1.2
12MHz Crystal	2	0.4	0.8	0.8
LM386 1W mono amp	2	0.95	1.9	1.9
IC Amp Stereo Headphone	1	2.55	2.55	2.55
STA540 IC Amp	1	3.34	3.34	3.34
LM4766 IC stereo 40W audio amp	1	6.5	6.5	6.5
LM4765 IC stereo 30W audio amp	1	7.45	7.45	7.45
Heatsink	1	1.98	1.98	1.98
10k Ohm linear rotary potentiometer	4	0.96	3.84	3.84
Arduino USB Board	2	30.00	60.00	60.00
Resistors, Capacitors	--	--	0 (In house)	Estimated $2
Total				**182.84**

BUDGET

- Remaining items to purchase:
  - LCD display (est. $25)
  - USB connector (est. $4)

DESKTOP AUDIO SYSTEM

Questions?